Development of a Next Generation Platform and Instrumentation for Continuous Ocean Observations (PICO)

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1. PROJECT SUMMARY

This continuation proposal requests funds to advance the state of NOAA's open ocean observation systems with the development of an easy to deploy and low cost mooring systems which make use of new and commercially available sensors and instrumentation and which addresses issues of improved data return rates in areas prone to vandal induced data losses. This effort is motivated by the need to develop a mooring system to replace and significantly improve upon the performance of existing ATLAS moorings used in NOAA's contribution to tropical moored buoy arrays in support of climate research and forecasting. A candidate mooring system presently under development at PMEL is the Platform and Instrumentation for Continuous ocean Observations (PICO) mooring. A web site containing comprehensive information on the system under development can be found at http://www.pmel.noaa.gov/pico/

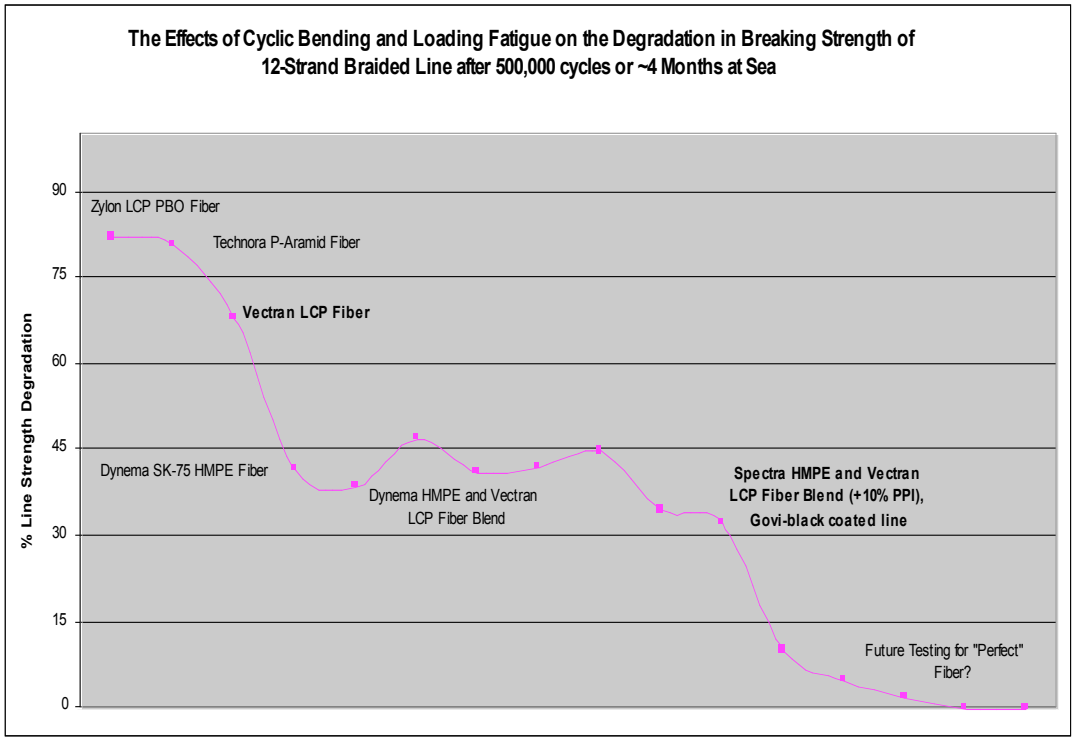
2. Accomplishments:

From FY '07 Work Statement:

a. Run test mooring line sections on the PMEL Dynamic Line Testing (DLT) machine to evaluate the design for repeated bending of synthetic mooring lines and strain relief terminations.

Results:

The PICO concept advocates a small, relatively inexpensive, vandal resistant buoy that can be easily deployed from ships / boats of opportunity. These requirements present significant engineering challenges, particularly in the design and development of a robust, highly survivable (5 year +) mooring system. The most complicated, and dynamic component of the PICO mooring system is the upper 700m jacketed line segment with inductive capability. With this in mind, we focused in FY'07 on the dynamic testing and characterization of six different mooring lines for the effects of repeated bending (400,000 cycles) on breaking strength of the mooring line. The results show that a blended Dyneema and Vectran line showed superior properties for mooring use. To our knowledge this type of basic mooring material testing has not been done in the community. A report titled: *Continued Development of a Slack Line, ReverseCatenary Mooring for a Small, Deep Ocean Instrument Platform; Lawrence-Slavas, 2007* was generated and will be presented at the upcoming ONR/MTS Buoyworkshop in early 2008.



b. Static and dynamic modeling of PICO lines to optimize performance through line design and configurations will be conducted. The WHOI Cable model will be used exclusively for this effort.

Results:

The effects, on the PICO mooring's dynamic responses, from the addition of a profiler, appear to be largely dependant upon the vertical location (depth) of the profiler. Fixing the profiler at a depth of 325m consistently yields the most severe results, and this location should be used for future mooring modeling. The profiler's effects on static tension and mooring catenary can be considered to be negligible. The influences of profiler depth on the vertical movement of the mooring remain inconclusive. Surprisingly, the addition of a weighted line section only has a moderate effect on the PICO mooring's catenary and line slope between 325m and 650m (at most 8%, assume the model has a "built-in" +-5% error). The addition of the weighted section has no beneficiary effect on the tension spread, but it does have a pronounced effect on the static tension at the buoy. Under calm current conditions and choppy seas the additional weight reduces the PICO buoy's tendency towards shock loading by greatly increasing the mean tension, while only slightly increasing the tension spread (see figure #32). Based on these results, it is recommended that the weighted line section be retained within the PICO mooring

c. Mooring hardware will be ordered to carryout two deep water deployments.

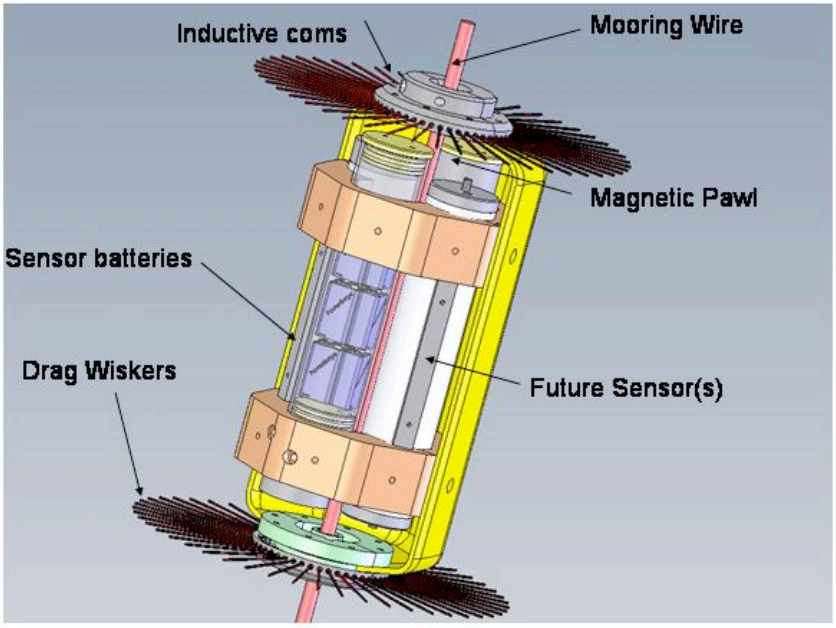
Results:

Despite the late arrival of funds, complete mooring systems were design and procured for deep water deployments and the system was tested with favorable results in Puget Sound for 5 days. An engineering ocean deployment is being planned for early in 2008 off San Diego or Hawaii in approx 3500m of water.

d. Continue development of a wave driven crawler mechanism for the PICO Profiler.

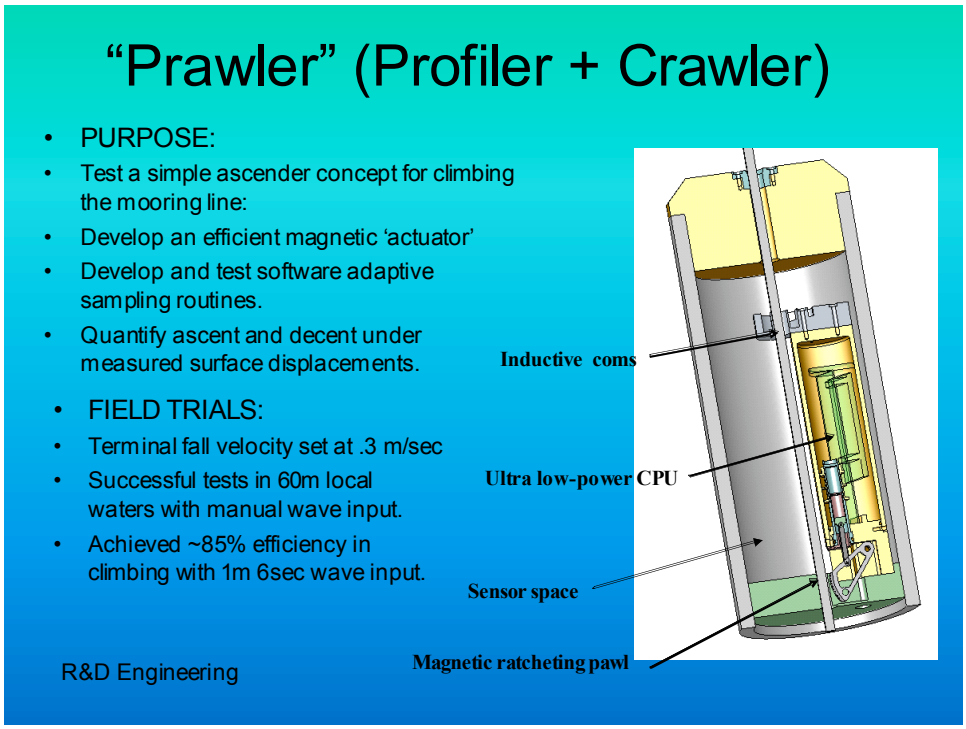
Results:

A novel wave driven crawler mechanism, now named "Prawler" (Profiler & Crawler) was built and tested in 2007. The Prawler uses the swell and wind wave energy from the surface buoy to engage and disengage a magnetically actuated pawl to climb the mooring line. Upon reaching a predetermined height a pawl releases and the Prawler falls at ~.3 m/s down the mooring line and samples the water column during decent. Present tests have been focused on collecting temp, pressure and engineering values, but future additions could include many type of sensors. During a 5 day test in Puget Sound the Prawler "prawled" and sampled over 3km in September 2007. These are very encouraging results, especially when considering the small waves that the buoy was subjected to in Puget Sound. With funding, a deep ocean test is being planned for early 2008 off San Diego or Hawaii.



PMEL ‘Prawler’ as deployed in Puget Sound

Prawler and PICO mooring tests and concepts were presented at the DBCP in Oct ’06 in Jeju, Korea.



e. Analyze data collected with prototype Seabird Jenna CTD and incorporate 2nd generation sensors, sampling and communications schemes.

Results:

PMEL developed FLEX, electronics, firmware and bi-directional software has been developed and is now deployed on the KEO and PAPA mooring systems as in-situ comparisons with the standard ATLAS systems. Partnerships were formed with Seabird Electronics and Teledyne RDI on next generation instrument development and some instruments are commercially available or nearly available.

The Doppler Volume Sampler (DVS) measures velocity profiles, temperature and is inductively coupled via a Seabird modem. PMEL and RDI worked closely on developing the specifications, testing and evaluating the instrument and is an exciting example how government and industry can partner to advance instrumentation. Complete details at: http://www.rdinstruments.com/dvs.html

The Seabird SBE-51 is being evaluated by Seabird and PMEL as a novel instrument to make high precision, long endurance conductivity measurements and transmit those data

via inductive modems. This sensor is still under evaluation and is currently deployed in the North Pacific for in-situ comparisons.

The FLEX electronic (data logger, telemetry and serial interface) systems are performing very well and within specifications. The systems are currently under in-situ evaluation at PAPA and KEO. Realtime data can be viewed for PAPA at: http://www.pmel.noaa.gov/stnP/data.html. The FLEX system was deployed in Sept '07 and the website in still under development.

RDI-PMEL partnership example:
Doppler Velocity Sampler